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CASE REPORT

A novel technique for invasive aortic valve pressure gradient measurement using a 6 Fr Swan-Ganz catheter: a case series

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Background Simultaneous left ventricular (LV) and aortic (Ao) pressure gradient assessment has been rendered challenging since the recall of the Langston catheter. Here we describe a simple method for simultaneous LV and Ao pressure gradient assessment using a Swan-Ganz catheter.

Case summary We describe two cases where assessment of simultaneous left ventricle and Ao valve gradients was done using a Swan-Ganz catheter to assess the degree of Ao stenosis and dynamic LV outflow obstruction.

Discussion Using Swan-Ganz catheter assessment of simultaneous left ventricle and Ao valve gradients can simplify the procedure with reduced cost and increased patient safety.

Keywords Case series • Dual lumen catheter • Aortic stenosis • Swan-Ganz

Learning points

- The Swan-Ganz catheter is a viable alternative for simultaneous assessment of the left ventricle–aortic (Ao) pressure gradient without a dual lumen Langston catheter.
- Using the Swan-Ganz catheter for Ao valve studies can reduce procedural cost and complications.

Introduction

Accurate assessment of aortic (Ao) stenosis when there is discrepancy between echocardiographic and clinical data requires invasive assessment of simultaneous left ventricular (LV) and Ao pressure gradients using a dual lumen catheter.[1] Due to the recall of the Langston dual lumen catheter,[2] such haemodynamic assessment has been rendered challenging. Various techniques have been described by operators and shared on social media to obtain LV–Ao gradients such as using a mother in child technique with a 6 or 7 Fr guide, a long sheath with a 4 Fr catheter inside, a fractional flow reserve (FFR) wire extending from the catheter, or dual arterial access.[3] All these techniques can be associated with increased cost, time, equipment, and complications from the larger arteriotomy size and need for dual arterial access.[4,5] Here we describe a simple and cost-effective technique of obtaining simultaneous LV–Ao gradients.

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Timeline

Case 1	
Day 1	Clinical assessment—shortness of breath
Day 4	Outpatient echocardiogram suggestive of mild–moderate aortic (Ao) stenosis
Day 10	Outpatient heart catheterization with the described technique to assess the degree of Ao stenosis
Case 2	
Day 1	Clinical assessment—shortness of breath
Day 3	Outpatient echocardiogram suggestive of left ventricular (LV) outflow tract obstruction
Day 7	Outpatient heart catheterization with the described technique to assess the degree of LV outflow tract obstruction

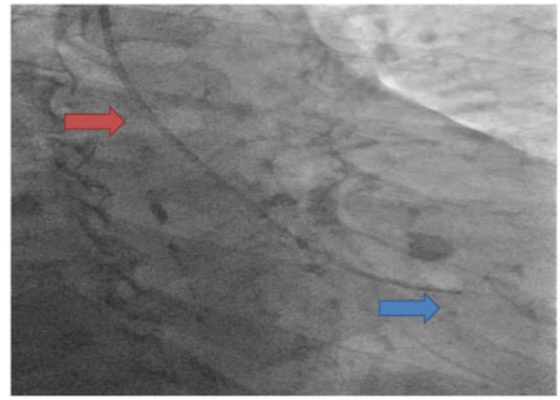

Figure 1 Swan-Ganz catheter in left ventricle. Blue arrow, distal transducer port position; red arrow, proximal transducer port position.

Case presentation

Through the slender 5/6 Fr sheath placed in the radial artery, the Ao valve was crossed using a Judkins Right 4 (JR4) catheter and 0.035″ straight tip wire. The catheter was introduced in the LV over this wire which was then swapped out for 300 cm 0.014″ Terumo Runthrough wire over which the JR4 catheter was exchanged for a 6 Fr Swan-Ganz catheter (Edwards), which was used earlier for the right heart catheterization, with the distal port in the LV and the proximal port in the Ao (*Figure 1*). The balloon on the Swan-Ganz catheter was deflated while the catheter was being advanced, and once in the LV, the balloon was inflated to help move the catheter away from LV wall, which might have caused pressure waveform dampening. Thus, simultaneous pressures could be obtained for the invasive haemodynamic assessment of Ao stenosis (*Figure 2*). Since the Swan-Ganz catheter is an end-hole catheter, this technique can also be used for the assessment of dynamic LV outflow obstruction (*Figure 3*), without the need for dual arterial access. In cases of subclavian tortuosity, the exchange can also be done over a long 0.025″ Swan wire or a 0.018″ wire, which might be easier.

Case 1

A 76-year-old male with history of hypertension and hyperlipidaemia presented with worsening shortness of breath. Cardiac workup showed a moderate risk stress test and mild–moderate Ao stenosis on echocardiogram with a mean gradient of 18 mmHg, Ao valve area of 1.4 mm^2, and peak velocity of 3.06 m/s (*Figure 4*). Due to body habitus, the echocardiogram images were not diagnostic. He also had an unremarkable chest X-ray and pulmonary function testing. Due to ongoing symptoms, the decision was made to proceed with heart catheterization which showed mild non-obstructive coronary artery disease and normal filling pressures. Mild Ao stenosis was confirmed with simultaneous LV–Ao gradients assessed via the above-described technique (*Figure 2*).

Case 2

A 51-year-old female with no cardiac risk factors presented with progressively worsening shortness of breath. Physical exam was consistent with a systolic murmur which increased with vagal manoeuvers. Echocardiogram showed normal ejection fraction, normal valvular structures with asymmetric septal hypertrophy, and turbulence in the LV outflow tract with a peak gradient of 56 mmHg at rest (*Figure 5*). The stress test was high risk. Heart catheterization showed normal coronary arteries and normal filling pressures. Simultaneous LV–Ao pressure gradients performed with the above technique using a Swan-Ganz catheter showed a resting peak LV outflow tract gradient of 113 mmHg, which increased to 164 mmHg with induction of premature ventricular contractions. The pullback confirmed that the obstruction was in the LV outflow tract (*Figure 3*).

Discussion

The above-described technique can be very useful in haemodynamic assessment of Ao stenosis or LV outflow tract obstruction in cases where the echocardiographic assessment may not be accurate and invasive gradient measurements are needed. With this technique, no extra equipment, larger or additional arteriotomy was needed. Therefore, this approach can help reduce costs and complications. Since the Swan-Ganz is an end-hole catheter, there can be pressure dampening if the catheter is against the LV wall. This can be overcome by balloon inflation and gentle readjustment of catheter position. To avoid the risk of air embolization from balloon rupture during balloon inflation, we recommend using saline or contrast for the balloon inflation. To the best of our knowledge, our report was the first to describe the above technique.[3]

The gradients obtained by this technique in the two cases above closely matched the echo gradients, and the waveforms appear undamped, which makes us believe that the assessment of gradients is very accurate. In the future, if the results of this method can be

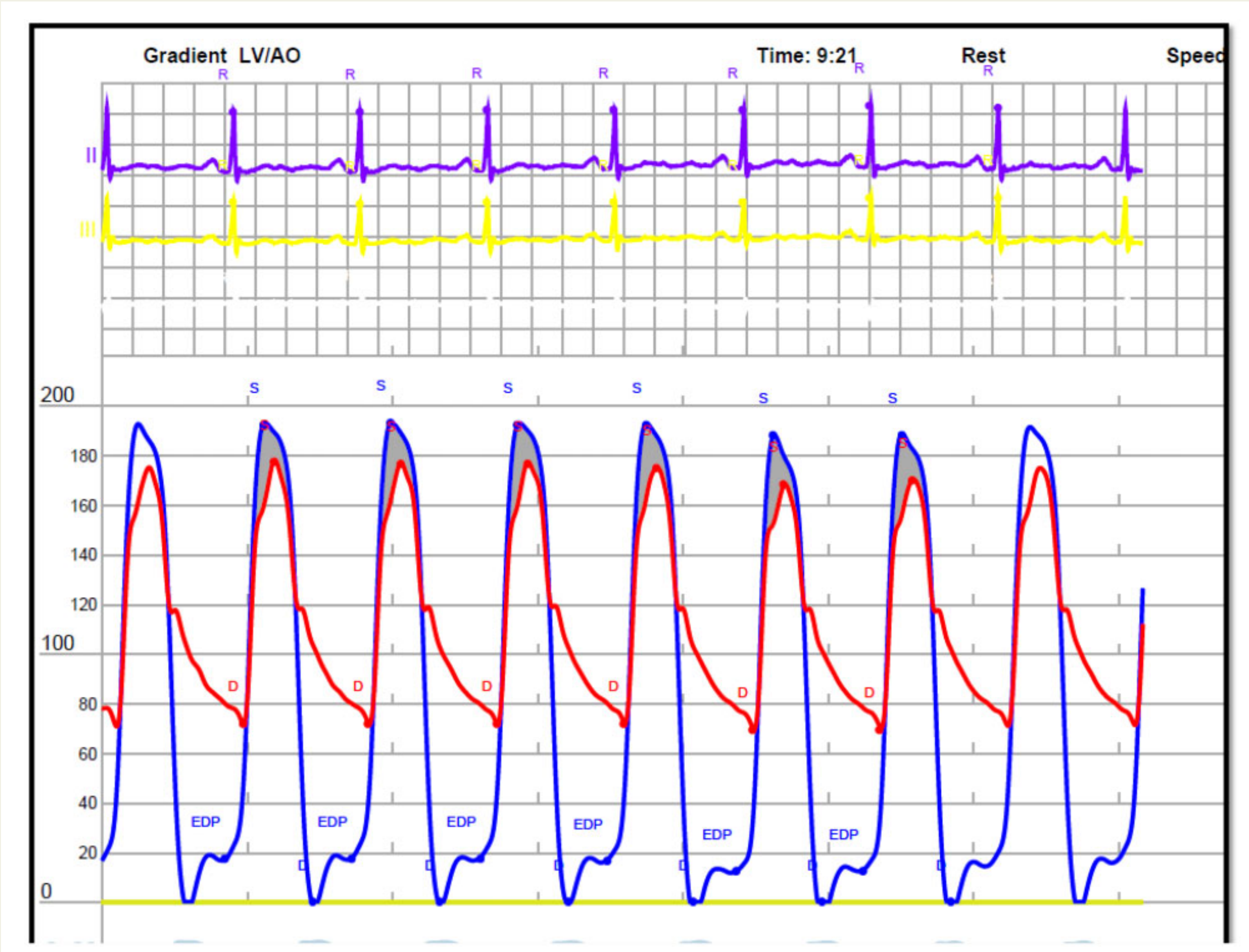

Figure 2 Simultaneous left ventricular and aortic gradient measurement across a stenosed aortic valve. Ao, aortic; Blue tracing, left ventricle; D, diastole; EDP, end-diastolic pressure; LV, left ventricular; Red tracing, aorta; S, systole.

validated by using two separate end-hole catheters simultaneously in the LV and Ao, then this technique can completely replace the need for a Langston dual lumen catheter for such assessment.

Lead author biography

Dr Nayan Agarwal is an interventional cardiologist at Cardiovascular Institute of the South in Louisiana. He finished his medical school in 2009 at Maulana Azad medical college in India and then pursued internal medicine residency followed by fellowship in cardiology and interventional cardiology at University of Florida, Gainesville.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: D.L.B. discloses the following relationships—Advisory Board: Cardax, CellProthera, Cereno Scientific, Elsevier Practice Update Cardiology, Janssen, Level Ex, Medscape Cardiology, MyoKardia, Novo Nordisk, PhaseBio, PLx Pharma, Regado Biosciences; Board of Directors: Boston VA Research Institute, Society of Cardiovascular Patient Care, TobeSoft; Chair: American Heart Association Quality Oversight Committee; Data Monitoring Committees: Baim Institute for Clinical Research (formerly Harvard

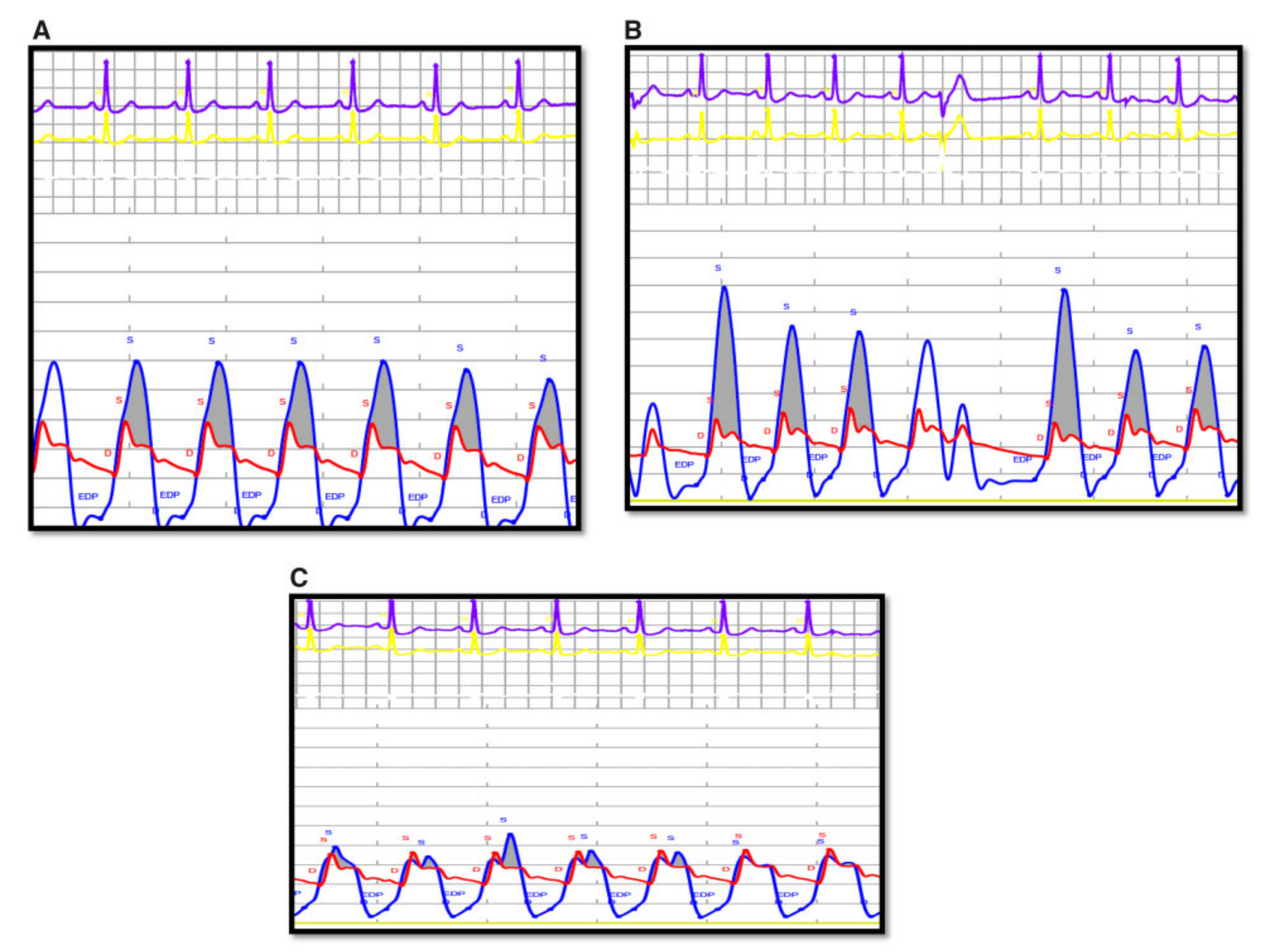

Figure 3 Assessment of dynamic left ventricular outflow obstruction. (*A*) Resting gradient between left ventricle and aorta. (*B*) Increasing gradient between left ventricle and aorta with induction of premature ventricular contraction with reduction in pulse pressure of aorta. (*C*) Pullback showing loss of left ventricle and aortic pressure gradient when catheter pulled back into left ventricular outflow tract. Blue tracing, left ventricle; D, diastole; EDP, end-diastolic pressure; Red tracing, aorta; S, systole.

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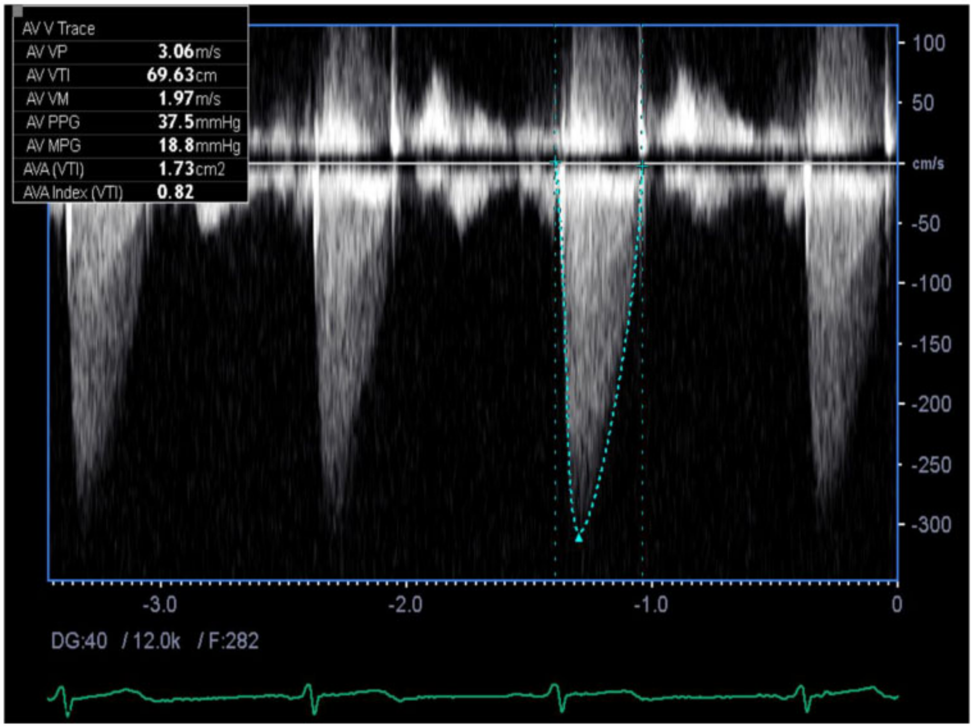

Figure 4 Echocardiogram continuous wave through aortic valve.

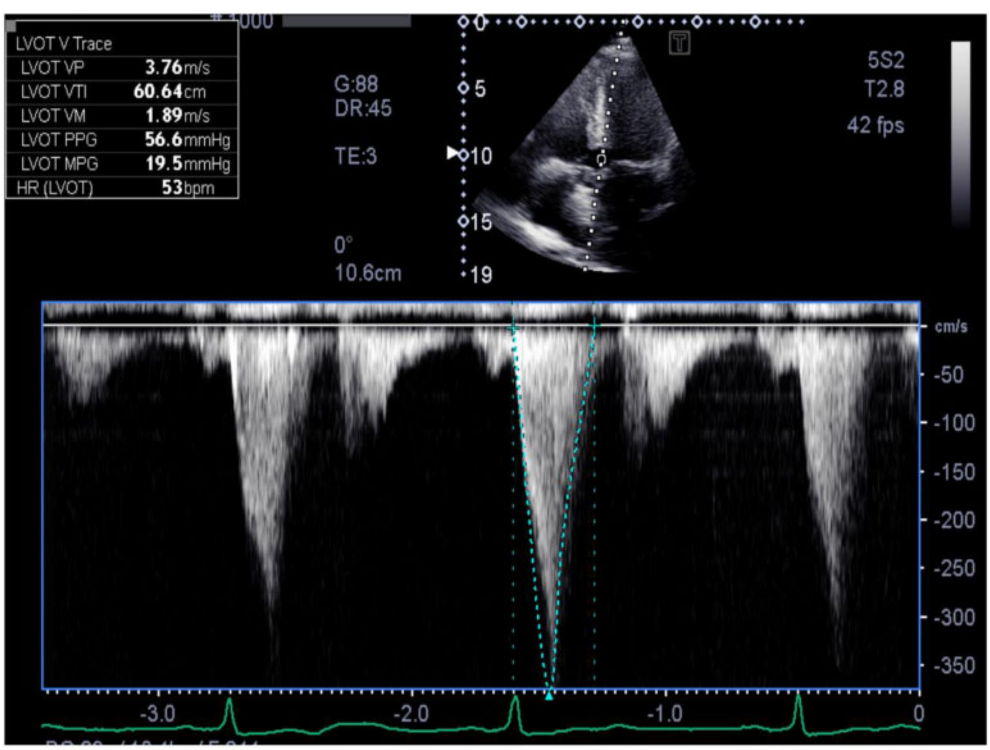

Figure 5 Echocardiographic resting gradient through left ventricular outflow tract.

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